Community Energy:

A critical review of the literature

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Abstract

We analyze the literature regarding community energy. We investigate the appearance of studies in the literature and the geographical orientation of the case studies, as well as the actual journals where the articles are published. We relate the articles to the theoretical approaches that are being employed. We analyze keywords used by the authors in their study of community energy and reflect on the country specifics of the case studies. We conclude that the study of community energy is still in its infancy as there is little commonality in the terminology and key concepts used. Further, we conclude that the theoretical underpinnings of studying community energy are in progress.

Keywords: community energy; renewable energy; literature review

1. Introduction

In several European countries, especially in Germany and Denmark, an increasing part of the production of renewable energy is contributed by citizen-owned production units, installed and managed individually or by local communities. Although in other countries, such as The Netherlands and the UK, the amount of installed citizen-owned power is less impressive, the number of local energy initiatives, who aim to increase local energy production, is rising rapidly.

The contribution of community energy to the energy transition is a dynamic phenomenon that attracts increasing attention in the literature (Araújo 2014, 112-121; Hauber and Ruppert-Winkel 2012, 491-530; Hielscher, Seyfang, and Smith 2013, 133-158). Local transitions to energy-neutral or low-carbon communities have been researched to a large extent by analysing cases(Alexander, Hope, and Degg 2007, 62-74; Hauber and Ruppert-Winkel 2012, 491-530; Hughes 2009, 108-123; Chmutina and Goodier 2013, 307-323; Forrest and Wiek 2014, 66-88; Trutnevyte, Stauffacher, and Scholz 2011, 7884-7895; Emelianoff 2014, 1378-1393). Other studies investigate emerging networks (Berkhout and Westerhoff 2013, 841-857; Parag et al. 2013, 1064-1077). This paper attempts to perform a literature review and to draw conclusions on what theoretical perspectives are used, to what extent commonalities and differences can be found between countries, and how to proceed to better understand patterns of local energy transitions.

In the literature several terms and definitions of community energy are used, such as citizen's power, grassroots energy, or local governance of energy production. Moreover, the role of the individual consumer or prosumer is often referred to. In this paper community energy is defined as local production of renewable energy, governed by citizens, with a view to contribute to the transition to a sustainable energy system.

First, we provide an overview of the appearance of community energy studies in the literature and the geographical orientation of the case studies, as well as the actual journals where the articles are published. Then, we link up with and complement the approach of Van den Bergh et al. regarding the theoretical approaches used in the sustainability transition literature. Next, we analyze the keywords used by the authors in their study of community energy. Lastly, we go into the country specifics of the case studies.

2. Materials and methods

We perform a literature search with Scopus in September 2015, using the search terms '*community energy*' and '*renewable',* which led to 412 results. In order to include as many relevant articles as possible we then extended our search with the search terms *decentralized energy, community engagement and local energy*. Furthermore, we used keywords found in these articles that directly relate to our subject as a further search term, including *low carbon communities, local energy governance, community action, decentralised energy, grassroots innovations, renewable energy, sustainable energy, energy autonomy.*

In order to limit our material to peer-reviewed articles, we excluded working papers, proceedings and book chapters. Furthermore, we fine-tuned the corpus to studies concerning citizens, local and regional projects and case studies, and excluded technical studies. Geographically our range is limited to studies regarding Europe, North America and Australia. We analysed the resulting list of research articles with Atlas.ti. Our findings provide an overview of the literature about local energy initiatives, both initiated by citizens and by municipalities. We focused on keywords, theoretical approaches and country distribution.

As a result, we ended up with 168 studies. These are all listed in Appendix A. In the remainder of this paper, the analysis is based on this sample.

3. Key characteristics of the community energy studies

This section gives an overview of the key characteristics of the studies about community energy that resulted from our screening process as described in the previous section. Figure 1 shows the development regarding the publication of the articles of interest in our review. The first paper we detected is that of Howard Jones in the Annals of the American Academy of Political and Social Sciences in 1938. This is the first study that addresses the (potential) role of community action in a democracy. Next is Zald and Ash's paper about the transformation of social movements in Social Forces in 1966. The third paper in our review appears 24 years later and is written by Megbolugbe et al. in Urban Studies regarding the reflections on neighbourhood change. Since then, there has been published at least one article every year, with the exception of 2002, that fulfils our criteria.

Figure 1 shows that the topic of community energy appears to take off in 2007. This is the first year when more than five articles have been published. This has been the case since then. Until 2007, for a period of almost 70 years, almost 20 percent of all studies in our sample were published. The other 80 percent were published in a period of nine years. Further, it shows that most studies have been published in 2010 and 2011. With 2011 being the year with the largest number of publications: one out of six studies in our sample was published in this year. For year 2015, we cannot report the full number of publications. Half of the number studies in our sample was published in the period 1938-2010, the other half was published in 2011-2015. About half of the studies focus on cases of energy communities.

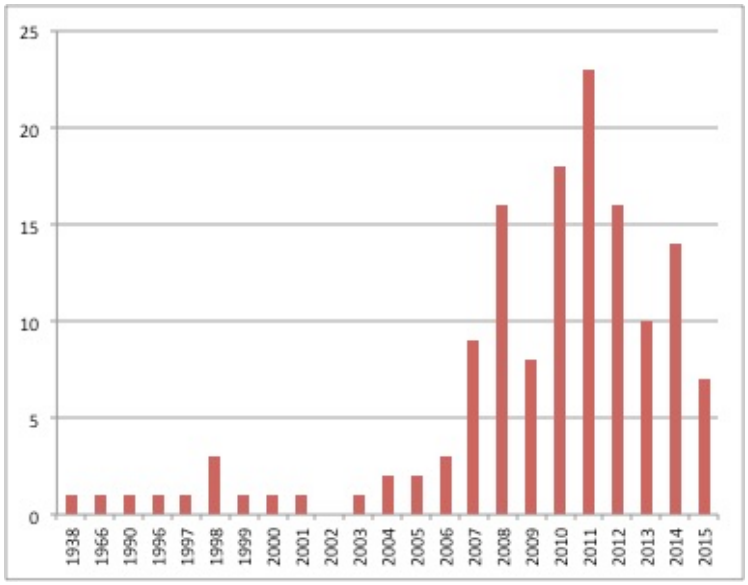

Figure 1: Year of publication of studies on community energy and number of studies published (vertical axis)

The geographical distribution of the case studies is depicted in Figure 2. This shows that community energy has been studied primarily for the UK: two out of five studies investigate community energy in the UK. Then Netherlands and Germany rank second and third in this respect. Combined, almost two thirds of all case studies investigate community energy in one of these three countries. This shows there is a huge bias. We will go deeper into the geographical dimension later on in this study.

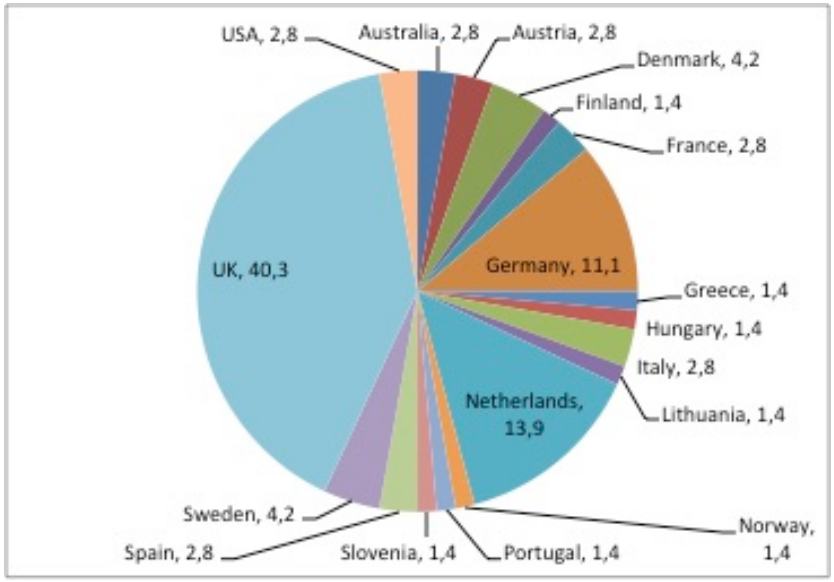

Figure 2: Geographical distribution of the case studies

The articles were published in 53 journals. But the distribution is very uneven, namely about half of the articles is published in five journals (Energy Policy, Renewable and Sustainable Energy Reviews, Environmental Innovation and Societal Transitions, Urban Studies, Research Policy). In fact, one third of all articles in the sample are

published in Energy Policy. Figure 3 gives an overview of the distribution. Figure 3 depicts the number of articles appearing in the journals. Before the semicolon is the number of papers appearing in the journals. After the semicolon is the percentage of the articles that did appear in the journals with this frequency. For example, 24.5% of the articles are published in journals that did publish only one article on community energy that was selected. Figure 3 reveals that journals with one article in the sample account for 25% of all the articles selected. Thirty-five journals of the 53 in the sample published one article that fulfilled the criteria we used. Journals that published two articles account for 11% of all the articles. Those with three articles held 4% and those with four 8%. There were two journals (Urban Studies and Research Policy) which both published five studies, combined this results in 7% of all the articles. There were seven publications in Environmental Innovation and Societal Transition (i.e. 5%) and eleven in Renewable and Sustainable Energy Reviews (i.e. 8%).

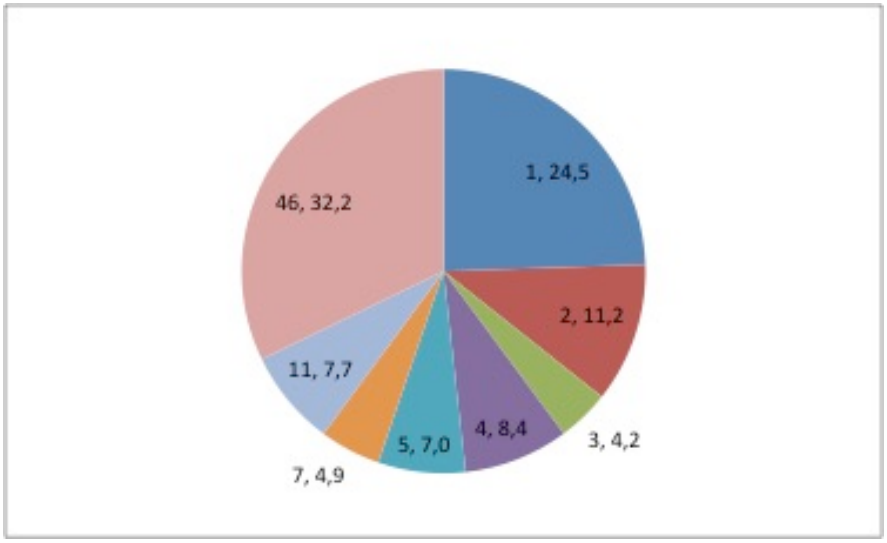

Figure 3: Composition of the distribution of the frequency of article publications

4. Results

In this study we analyse the theoretical perspective used in the community energy studies. We first assess different approaches being used in this literature. Then, we try to find out which approaches are being used for case studies in particular countries. Last is that we investigate the keywords used in community energy studies.

4.1 Theoretical approaches

Community energy studies show a wide variety of theoretical approaches and disciplines. To analyse this matter we first investigate the theoretical approaches, on the basis of the abstracts. Our categorization of research approaches to sustainability transitions is partly derived from Van den Bergh et al. (Van den Bergh, Jeroen CJM, Truffer, and Kallis 2011, 1-23) , who identifies four broad clusters of systemic approaches: Innovation systems, Multi-level perspective, Complex systems and Evolutionary systems. These approaches use specific key concepts, and have a related policy view. However,

Van den Bergh recognizes that the boundary between approaches is not very sharp and there is considerable overlap in concepts.

Another theoretical framework that also is relevant for the study of community energy is Social Practice Theory, as outlined among others by Shove and Hargreaves (Shove and Walker 2010, 471-476; Hargreaves, Longhurst, and Seyfang 2013, 402-420). Specific disciplines also bring their own approaches, foregrounding individual behavioural aspects and acceptance (psychology), organisational aspects (sociology/ social-psychology), or governance (political sciences). Furthermore, we find spatial sciences and landscape design studies of urban or rural energy development.

Innovation systems. The innovation systems (IS) approach identifies system failures, looking at institutional patterns and knowledge networks ((Jacobsson and Bergek 2011, 41-57). In the field of renewable energy Negro points to a series of barriers which hinder diffusion of renewable energy technology (Negro, Alkemade, and Hekkert 2012, 3836-3846) . In our sample this approach is not specifically used to analyse community energy.

Multi-level perspective (1) The multi-level perspective (MLP) was grounded by Geels (Geels 2002, 1257-1274; Geels 2011, 24-40). From this approach strategic niche management was derived, to apply MLP in policy development (Schot and Geels 2008, 537-554). In our sample several authors conceptualize local communities as a niche, a protected space that according to the MLP scheme will in time influence the current regime. Seyfang et. al position communities as a specific niche: 'grassroots' (Seyfang et al. 2014a, 21-44). On another level in the MLP we find regimes, clusters of incumbent actors, institutions and policies that protect the status quo. This concept is critically analysed by Strunz in relation to the German Energiewende (Strunz 2014, 150-158).

Complex systems. The complex systems approach was grounded by Rotmans and Loorbach (Rotmans and Loorbach 2009, 184-196). In our sample the concept of transition management (TM) is often referred to, but authors tend to relate this to MLP and do not use it as a separate approach. Therefore we will not go further into the complex systems approach.

Evolutionary systems (2). Central concepts in the evolutionary systems approach are path dependence and lock in, which point to the obduracies in a technological system due to earlier investments and decisions (Garud and Karnøe 2003, 277-300). This approach is for example used by (Heiskanen, Lovio, and Jalas 2011, 1892-1900; Heiskanen et al. 2010, 7586-7595)

Social Practice Theory (3). Social Practice Theory (SPT) looks how social practices, such as cooking, driving or showering, evolve over time. Practices have also been related to innovation. This approach is applied to community energy by Shove and Walker (Shove and Walker 2010, 471-476) , while Hargreaves et. al aim to combine SPT with the Multi-level perspective (Hargreaves, Longhurst, and Seyfang 2013, 402-420) .

Acceptance perspective (4). There is a substantial literature that highlights acceptance of renewable energy projects, including NIMBY-ism and the influence of community benefits on acceptance (Wolsink 2012, 822-835; Wüstenhagen, Wolsink, and Bürer 2007, 2683-2691). In this literature there have been contributions discussing the criteria by which a community energy initiative may be judged (Zoellner, Schweizer-Ries, and Wemheuer 2008, 4136-4141). The concept of procedural justice is investigated in Germany, in a qualitative psychological study by Schweitzer-Ries(Schweizer-Ries 2008, 4126-4135). Going from acceptance&resistance to activism we find studies after motives for action in their analysis of Scottish energy initiatives (Bomberg and McEwen 2012, 435-444).

Governance oriented studies (5). Municipalities and cities have been included in this search, because they also represent initiatives on a local level. In the cases included in this overview much attention was given to participation of citizens in the municipal projects. This approach also refers to local environmental and energy policies.

Spatial design (6). Lastly, we mention spatial sciences (Coenen, Benneworth, and Truffer 2012, 968-979) and design as a separate approach, although there could be some overlap with policy studies as mentioned under governance.

Approach	Documents	Frequency
Multi-level perspective	2, 3, 7, 9, 30, 37, 67, 86, 103, 124, 132,	11
Evolutionary systems	49, 76	2
Social Practice Theory	10, 23, 84, 159, 180	5
Acceptance perspective	11, 57, 58, 59	4
Governance oriented studies	14, 31, 39, 48, 65, 87, 103, 124, 139	9
Spatial design	22, 24, 47, 101, 102	5

Table 1. Approaches in the literature (preliminary results)

4.2 Theoretical approaches by country

Next, we grouped the found documents according to theoretical approaches by country. We first discuss the literature regarding the countries that are studied most and then will provide a comparative assessment. For this paper we focused on four countries: UK, Denmark, Germany and the Netherlands

The MLP approach appears to be rather popular in the UK, especially the concept of niches engenders many studies (Seyfang et al. 2014b; Hielscher, Seyfang, and Smith 2011, 22). Here, local energy initiatives are conceptualized as niches, which according to MLP theory can eventually influence the energy system. The niches approach is challenged by Middlemiss (Middlemiss and Parrish 2010, 7559-7566), pointing to the need for communities to have resources and power to adequately influence the energy regime. North(North 2011, 1581) further investigates the power of 'green niches' in his study after social movements and climate activism. Linked to the niche approach is the concept of grassroots, which is however almost exclusively used by Seyfang and co-

authors (Seyfang et al. 2014a, 21-44; Seyfang and Smith 2007, 584-603). Social practices are discussed by Walker et al, indicating that several practices are developing in the direction of higher instead of lower energy use. Furthermore, Walker also critically reflects on the rigidity of the concepts of niches and regimes, proposing the term 'mode' instead, allowing for a greater heterogeneity.

Denmark is often quoted as an example of successful policies for implementing renewable energy; furthermore attention is drawn to the strength of cooperative local ownership. According to Reiche (Reiche and Bechberger 2004, 843-849), Denmark has more than 3000 cooperatively owned windmills; the cooperative model increased the acceptance of wind turbines. Samso is a widely known example of a 100% energy self-sufficient island, as Neves (Neves, Silva, and Connors 2014, 935-946) mentions. Also Rea and Slee (Slee 2015, 540-549; Rae and Bradley 2012, 6497-6506) refer to the successful Danish approach based on community governance. In Lehmans et. al several EU countries, including Denmark, are compared, placed in a evolutionary perspective where path dependency and lock in are central concepts.

In The Netherlands, where the MLP approach originally came from (Verbong and Geels 2007, 1025-1037), Doci (Doci, Vasileiadou, and Petersen 2015, 85-95) investigates the contribution of local energy initiatives as to energy transition. These initiatives are seen as niches, defined as protected spaces for innovation. They stress that these cooperatives are not aiming for technological innovation, but introduce social innovations and new energy production practices. Bosman et. al (Bosman et al. 2014, 45-59) analyze discourses in the energy regime, concluding that there are conflicting storylines within the incumbent regime, which might indicate regime dynamics. The storyline relating to decentralized energy for example is varying widely between regime actors, indicating uncertainty within the regime. In comparison with Denmark the Dutch policy is complicated, bureaucratic and remarkably ineffective, as Blokhuis (Blokhuis, Advokaat, and Schaefer 2012, 680-690) shows. Social Practices Theory is used as perspective by Van Vliet et. al (van Vliet 2012, 263-278), studying the influence of the Smart Meter on energy related practices in the household.

In Germany the majority of the studies are not specifically relating to the theoretical approaches we identified. However, some studies such as Hauber et. al (Hauber and Ruppert-Winkel 2012, 491-530) are considering MLP as a framework, although critically reflecting on some of its assumptions. Strunz (Strunz 2014, 150-158) contrasts the MLP with a resilience framework, thus highlighting aspects of interrelations between scales that have been underrated in the literature due to MLP dominance. Sühlsen (Sühlsen and Hisschemöller 2014, 316-325) uses an MLP-perspective to study the 'big four', the incumbents' lobbying activities. She states that the renewable energy sector in Germany is no longer a niche, but is incorporated in the energy regime. Kungl (Kungl 2015, 13-23) also investigates the incumbents' strategies and activities, using the theory of strategic action fields. Here, niches are created by the less-powerful challengers, while the powerful incumbents defend their position. Lastly, the acceptance approach is proposed by Schweitzer-Ries et al (Schweizer-Ries 2008, 4126-4135; Zoellner, Schweizer-Ries, and Wemheuer 2008, 4136-4141).

In Germany the phenomenon of the Energiewende, in particular in relation to local initiatives is a growing research niche (Sühlsen and Hisschemöller 2014, 316-325; Moss, Becker, and Naumann 2014; Buchan 2012) . Beveridge (Beveridge and Kern 2013, 3) outlines the development, policies and future challenges of the Energiewende.

This summarizing overview shows that MLP appears rather dominant in the community energy literature. Nevertheless, rival theories such as Social Practice theory; strategic action fields or social acceptance also can count on followers.

4.3 Keywords

The third angle is the analysis of the keywords that are provided by authors in the corpus of studies, including the frequency of use. We investigated the use of keywords for articles published in 2007-2015. This is because we see a remarkable increase in the number of publications in 2007 and therefore concentrate on this literature.

In the articles studied, it appears that the authors assign 364 different keywords to their manuscripts; Appendix B lists all keywords encountered in the literature. Thus, the average is about two and a half keyword per article. Most studies provide two or three keywords, but in some cases up to six keywords are provided. In total, 566 keywords were coined in the selected articles. Implying that on average a keyword was used 1.6 times.

Figure 4 gives an overview of the distribution of the keywords in the papers studied. The very recent emergence of the study of energy communities can be held responsible for the extremely wide dispersion as 82% of the keywords provided is only used once. This suggests that just less than one in five of all 364 keywords is used in more than one article. But the distribution clearly is very uneven. 33 keywords are used in two articles, 12 keywords in three articles, etc. The keyword used most ('renewable energy') was used in 23 articles.

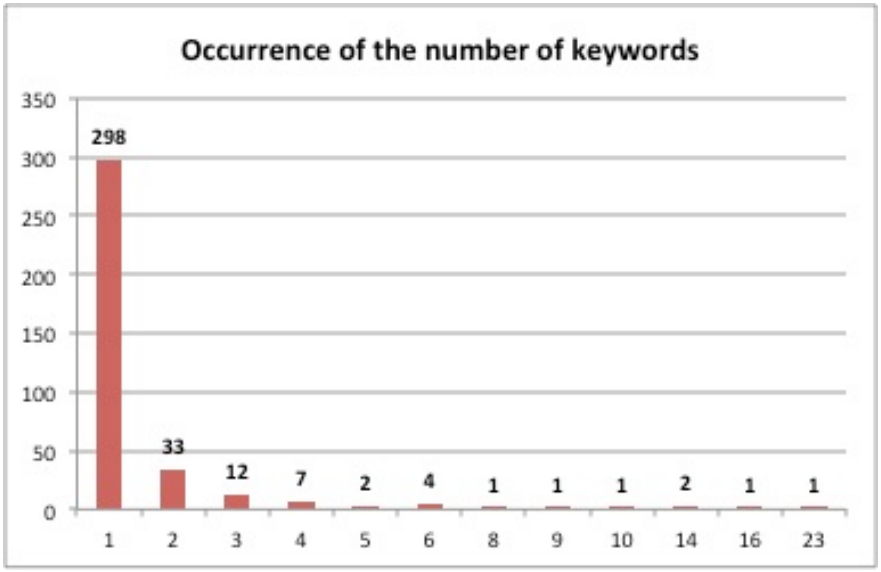

Figure 4: Occurrence of the number of keywords

Figure 5 provides an overview of the keywords used at least in five articles. Please note that this pertains to fourteen different keywords, which is less than 4% of the total number of keywords. However, these fourteen keywords together are covering almost 25% of all the keywords. The keyword used most ('renewable energy') appeared in about one in six of the articles. 'Governance' is used in every one out of eight of the articles. 'Niche' and 'grassroots' are used in one out of ten articles, etc.

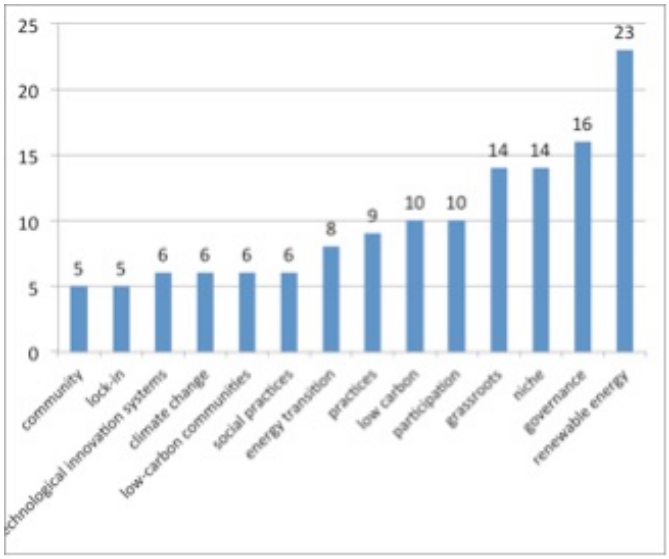

Figure 5: Keywords in the community energy literature used more than five times in the articles

5 Conclusion

We analyse the literature regarding community energy. Based on relevant criteria, we ended up with 140+ studies, which appeared in academic journals. The oldest paper origins from 1938 and most articles did appear in 2011. In fact, the majority of the studies on community energy were published in the last five years. Thus, it shows that it is a relatively new area of research. This is also witnessed by the huge dispersion of keywords. Of the 364 keywords listed with the articles by the authors themselves, it shows that 298 are used only once. We observed that the articles were published in 53 journals. But the outlets of the articles were highly concentrated with Energy Policy holding one third of all the articles. And 35 journals so far published just one single article on community energy. We focus on case studies and establish that most of them were undertaken for the UK, namely two out of five case studies. We also relate the articles to the theoretical approaches that are being employed. Here, it shows that there is a wide variety in approaches used to study community energy. There is room to further reflect on the agency that is employed by these communities and how this relates to niches or governance approaches.

We conclude that the study of community energy is still in its infancy as there is little commonality in the terminology and key concepts used. Moreover, the topic lacks consensus about appropriate theories and common methodologies. Also the number of outlets is very limited at this stage.

Here, we want to point out that this paper is only a preliminary result of our inquiries, as we are still in the process of finalizing our findings.

Bibliography

Alexander, Roy, Max Hope, and Martin Degg. 2007. "Mainstreaming Sustainable Development–a Case Study: Ashton Hayes is Going Carbon Neutral." *Local Economy* 22 (1): 62-74.

Araújo, Kathleen. 2014. "The Emerging Field of Energy Transitions: Progress, Challenges, and Opportunities." *Energy Research & Social Science* 1: 112-121.

Berkhout, T. and L. Westerhoff. 2013. "Local Energy Systems: Evaluating Network Effectiveness for Transformation in British Columbia, Canada." *Environment and Planning C: Government and Policy* 31 (5): 841-857.

Beveridge, Ross and Kristine Kern. 2013. "Energiewende in Germany: Background, Developments and Future Challenges, The." *Renewable Energy L.& Pol'Y Rev*.: 3.

Blokhuis, Erik, Bart Advokaat, and Wim Schaefer. 2012. "Assessing the Performance of Dutch Local Energy Companies." *Energy Policy* 45: 680-690.

Bomberg, Elizabeth and Nicola McEwen. 2012. "Mobilizing Community Energy." *Energy Policy* 51 (0): 435-444.

Bosman, Rick, Derk Loorbach, Niki Frantzeskaki, and Till Pistorius. 2014. "Discursive Regime Dynamics in the Dutch Energy Transition." *Environmental Innovation and Societal Transitions* 13 (0): 45-59.

Buchan, David. 2012. *The Energiewende-Germany's Gamble* Oxford Institute for Energy Studies Oxford, UK.

Chmutina, Ksenia and Chris I. Goodier. 2013. "Case Study Analysis of Urban Decentralised Energy Systems." In *Climate-Smart Technologies*, 307-323: Springer.

Coenen, Lars, Paul Benneworth, and Bernhard Truffer. 2012. "Toward a Spatial Perspective on Sustainability Transitions." *Research Policy* 41 (6): 968-979.

Doci, Gabriella, Eleftheria Vasileiadou, and Arthur C. Petersen. 2015. "Exploring the Transition Potential of Renewable Energy Communities." *Futures* 66: 85-95.

Emelianoff, C. 2014. "Local Energy Transition and Multilevel Climate Governance: The Contrasted Experiences of Two Pioneer Cities (Hanover, Germany, and Växjö, Sweden)." *Urban Studies* 51 (7): 1378-1393.

Forrest, Nigel and Arnim Wiek. 2014. "Learning from success—Toward Evidence-Informed Sustainability Transitions in Communities." *Environmental Innovation and Societal Transitions* 12 (0): 66-88.

Garud, Raghu and Peter Karnøe. 2003. "Bricolage Versus Breakthrough: Distributed and Embedded Agency in Technology Entrepreneurship." *Research Policy* 32 (2): 277-300. doi:10.1016/S0048-7333(02)00100-2.

Geels, Frank W. 2011. "The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms." *Environmental Innovation and Societal Transitions* 1 (1): 24-40.

———. 2002. "Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study." *Research Policy* 31 (8): 1257-1274.

Hargreaves, Tom, Noel Longhurst, and Gill Seyfang. 2013. "Up, Down, Round and Round: Connecting Regimes and Practices in Innovation for Sustainability." *Environment and Planning A* 45 (2): 402-420.

Hauber, Jürgen and Chantal Ruppert-Winkel. 2012. "Moving Towards Energy Self-Sufficiency Based on Renewables: Comparative Case Studies on the Emergence of Regional Processes of Socio-Technical Change in Germany." *Sustainability* 4 (4): 491-530.

Heiskanen, Eva, Mikael Johnson, Simon Robinson, Edina Vadovics, and Mika Saastamoinen. 2010. "Low-Carbon Communities as a Context for Individual Behavioural Change." *Energy Policy* 38 (12): 7586-7595.

Heiskanen, Eva, Raimo Lovio, and Mikko Jalas. 2011. "Path Creation for Sustainable Consumption: Promoting Alternative Heating Systems in Finland." *Journal of Cleaner Production* 19 (16): 1892-1900.

Hielscher, S., G. Seyfang, and A. Smith. 2011. *Community Innovation for Sustainable Energy*.

Hielscher, Sabine, Gill Seyfang, and Adrian Smith. 2013. "Grassroots Innovations for Sustainable Energy: Exploring Niche Development Processes among Community Energy Initiatives." *Innovations in Sustainable Consumption: New Economics, Socio-Technical Transitions, and Social Practices, Cheltenham, Edward Elgar Publishing*: 133-158.

Hughes, Kristen. 2009. "An Applied Local Sustainable Energy Model: The Case of Austin, Texas." *Bulletin of Science, Technology & Society* 29 (2): 108-123.

Jacobsson, Staffan and Anna Bergek. 2011. "Innovation System Analyses and Sustainability Transitions: Contributions and Suggestions for Research." *Environmental Innovation and Societal Transitions* 1 (1): 41-57.

Kungl, Gregor. 2015. "Stewards Or Sticklers for Change? Incumbent Energy Providers and the Politics of the German Energy Transition." *Energy Research & Social Science* 8: 13-23.

Middlemiss, Lucie and Bradley D. Parrish. 2010. "Building Capacity for Low-Carbon Communities: The Role of Grassroots Initiatives." *Energy Policy* 38 (12): 7559-7566.

Moss, Timothy, Sören Becker, and Matthias Naumann. 2014. "Whose Energy Transition is it, Anyway? Organisation and Ownership of the Energiewende in Villages, Cities and Regions." .

Negro, Simona O., Floortje Alkemade, and Marko P. Hekkert. 2012. "Why does Renewable Energy Diffuse so Slowly? A Review of Innovation System Problems." *Renewable and Sustainable Energy Reviews* 16 (6): 3836-3846.

Neves, Diana, Carlos A. Silva, and Stephen Connors. 2014. "Design and Implementation of Hybrid Renewable Energy Systems on Micro-Communities: A Review on Case Studies." *Renewable and Sustainable Energy Reviews* 31 (0): 935-946.

North, Peter. 2011. "The Politics of Climate Activism in the UK: A Social Movement Analysis." *Environment and Planning-Part A* 43 (7): 1581.

Parag, Yael, Jo Hamilton, Vicki White, and Bernie Hogan. 2013. "Network Approach for Local and Community Governance of Energy: The Case of Oxfordshire." *Energy Policy* 62 (0): 1064-1077.

Rae, Callum and Fiona Bradley. 2012. "Energy Autonomy in Sustainable communities—A Review of Key Issues." *Renewable & Sustainable Energy Reviews* 16 (9): 6497-6506.

Reiche, Danyel and Mischa Bechberger. 2004. "Policy Differences in the Promotion of Renewable Energies in the EU Member States." *Energy Policy* 32 (7): 843-849.

Rotmans, Jan and Derk Loorbach. 2009. "Complexity and Transition Management." *Journal of Industrial Ecology* 13 (2): 184-196.

Schot, J. and F. W. Geels. 2008. "Strategic Niche Management and Sustainable Innovation Journeys: Theory, Findings, Research Agenda, and Policy." *Technology Analysis and Strategic Management* 20 (5): 537-554.

Schweizer-Ries, Petra. 2008. "Energy Sustainable Communities: Environmental Psychological Investigations." *Energy Policy* 36 (11): 4126-4135.

Seyfang, Gill, Sabine Hielscher, Tom Hargreaves, Mari Martiskainen, and Adrian Smith. 2014a. "A Grassroots Sustainable Energy Niche? Reflections on Community Energy in the UK." *Environmental Innovation and Societal Transitions* 13 (0): 21-44.

———. 2014b. "A Grassroots Sustainable Energy Niche? Reflections on Community Energy in the UK." *Environmental Innovation and Societal Transitions* (13 (0):21).

Seyfang, Gill and Adrian Smith. 2007. "Grassroots Innovations for Sustainable Development: Towards a New Research and Policy Agenda." *Environmental Politics* 16 (4): 584-603.

Shove, Elizabeth and Gordon Walker. 2010. "Governing Transitions in the Sustainability of Everyday Life." *Research Policy* 39 (4): 471-476.

Slee, Bill. 2015. "Is there a Case for Community-Based Equity Participation in Scottish on-Shore Wind Energy Production? Gaps in Evidence and Research Needs." *Renewable and Sustainable Energy Reviews* 41 (0): 540-549.

Strunz, Sebastian. 2014. "The German Energy Transition as a Regime Shift." *Ecological Economics* 100: 150-158.

Sühlsen, Kathrin and Matthijs Hisschemöller. 2014. "Lobbying the 'Energiewende'. Assessing the Effectiveness of Strategies to Promote the Renewable Energy Business in Germany." *Energy Policy* 69: 316-325.

Trutnevyte, Evelina, Michael Stauffacher, and Roland W. Scholz. 2011. "Supporting Energy Initiatives in Small Communities by Linking Visions with Energy Scenarios and Multi-Criteria Assessment." *Energy Policy* 39 (12): 7884-7895.

Van den Bergh, Jeroen CJM, Bernhard Truffer, and Giorgos Kallis. 2011. "Environmental Innovation and Societal Transitions: Introduction and Overview." *Environmental Innovation and Societal Transitions* 1 (1): 1-23.

van Vliet, Bas J. M. 2012. "Sustainable Innovation in Network-Bound Systems: Implications for the Consumption of Water, Waste Water and Electricity Services." *Journal of Environmental Policy & Planning* 14 (3): 263-278.

Verbong, Geert and Frank Geels. 2007. "The Ongoing Energy Transition: Lessons from a Socio-Technical, Multi-Level Analysis of the Dutch Electricity System (1960–2004)." *Energy Policy* 35 (2): 1025-1037.

Wolsink, Maarten. 2012. "The Research Agenda on Social Acceptance of Distributed Generation in Smart Grids: Renewable as Common Pool Resources." *Renewable & Sustainable Energy Reviews* 16 (1): 822-835.

Wüstenhagen, Rolf, Maarten Wolsink, and Mary Jean Bürer. 2007. "Social Acceptance of Renewable Energy Innovation: An Introduction to the Concept." *Energy Policy* 35 (5): 2683-2691.

Zoellner, Jan, Petra Schweizer-Ries, and Christin Wemheuer. 2008. "Public Acceptance of Renewable Energies: Results from Case Studies in Germany." *Energy Policy* 36 (11): 4136-4141.

Appendix A. List of Articles

1	2015	Beyraghi	Energy in sustainability research, A recent rise to prominence
2	2007	Verbong	The ongoing energy transition, Lessons from a socio-technical multi-level analysis of the Dutch electricity system (1960-2004)
3	2013	Verbong	Smart grids or smart users? Involving users in developing a low carbon electricity economy
4	2012	van Vliet	Sustainable Innovation in Network-bound systems, Implications for the Consumption of Water, Waste water and electricity services
5	2006	van Rooijen	Green electricity policies in the Netherlands, an analysis of policy decisions
6	2012	Vanesa	Social housing and low carbon transitions in Ljubljana, Slovenia
7	2012	Smith	What is protective space? Reconsidering niches in transitions to sustainability
8	2008	Smith	Designing urban spaces and buildings to improve sustainability and quality of life in a warmer world
9	2010	Smith	Innovation studies and sustainability, The allure of the multi-level perspective and its challenges
10	2010	Shove	Social Theory and Climate change, Questions often, sometimes and Not Yet asked
11	2008	Schweizer-Ries	Energy sustainable communities, Environmental Psychological investigations
12	2011	Schimschar	Germany's path towards nearly zero-energy buildings-Enabling the greenhouse gas mitigation potential in the building stock
13	2000	Roseland	Sustainable community development, integrating environmental, economic and social objectives
14	2004	Reiche	Policy differences in the promotion of renewable energies in the EU member states
16	2014	Nevels	Design and implemention of hybrid renewable energy systems on micro-communities, A review on case studies
17	2012	Negro	Why does renewable energy diffuse so slowly? A review of innovation system problems
18	2010	Mulugetta	Carbon reduction at community scale
19	2010	Mulugetta	Deliberating on low carbon development
20	2010	Moe	Energy, industry and politics, Energy, vested interests and long-term economic growth and development
21	2012	Farla	Sustainability transitions in the making, A closer look at actors, strategies and resources
22	2011	Davies	Low carbon housing refurbishment challenge and incentives-Architects perspectives
23	2006	Darby	Social learning and public policy, Lessons from an energy-conscious village
24	2012	Coenen	Toward a spatial perspective on sustainability transitions
25	2011	Connors	Transitioning communities, community, participation and the transition town movement
26	2013	Carvalho	Wood-burning stoves in low-carbon dwellings
27	2008	Carlsson	Participative backcasting, A tool for involving stakeholders in local sustainability planning
28	2011	Bonnemaizon	How competent are consumers? The case of the energy sector in France
30	2014	Bosman	Discursive regime dynamics in the Dutch energy transition
31	2014	Bobinaite	Financing instruments and channels for the increasing production and consumption of renewable energy, Lithuanian case
33	2012	Blokhuis	Assessing the performance of Dutch local energy companies
34	2013	Bhagavatula	Bridging the gap between science and practice, an ICLEI perspective
35	2007	Barber	Mapping the movement to achieve sustainable production and consumption in North America
37	2015	Docie	Exploring the Transition potential of RE communities - FUTURES
38	2005	Zeuli	Cooperatives as a community development strategy
39	2013	Beveridge	Explaining the Energiewende in Germany, Background, Development and future challenges
41	1997	Roseland	Dimensions-of-the-eco-city
43	2007	Seyfang	Grassroots innovations for sustainable development, Towards a new research and policy agenda
44	2012	Rae	Energy autonomy in sustainable communities - A review of key issues 2012
45	2012	Schmidt	Regional energy autarky, potentials costs and consequences for an Austrian region
47	2011	Dobbelsteen	Energy Potential Mapping for Energy-Producing Neighborhoods
48	2011	Muller	Energy autarky, A conceptual framework for sustainable regional development

49	2012	Lehmans	Carbon lock out, Advancing renewable energy policy in Europe
50	2011	Vergragt	Backcasting for sustainability, Introduction to the special issue
51	2007	Martensson	How to transform local energy systems towards bioenergy, three strategy models for transformation
52	2015	Kungl	Stewards or Sticklers for Change, Incumbent Energy Providers and the Politics of the German Energy Transition.
53	2014	Fressoli	When grassroots innovation movements encounter mainstream institutions, implications for models of inclusive innovation
55	2015	Walker	Zero carbon homes and zero carbon living, socio-material interdependencies in carbon governance
57	2008	Zoellner	Public acceptance of renewable energys, results form case studies in Germany
58	2007	Wustenhage n	Social acceptance of renewable energy innovation, an introduction to the concept
59	2012	Wolsink	The research agenda
60	2007	Walker	Carbon reduction, the public and renewable energy
61	2010	Walker	Trust and community, exploring the meanings, contexts and dynamics of community renewable energy
62	2008	Walker	Community renewable, what should it mean
63	2008	Walker	What are the barriers and incentives for community owned means of energy production and use
64	2009	St. Denis	Community energy planning in Canada, the role of renewable energy
65	2011	Sperling	Centralisation and decentralisation in strategic municipal energy planning in Denmark
66	2013	Seyfang	Desperately seeking niches-Grassroots innovations
67	2014	Seyfang	A grassroots sustainable energy niche, Reflections on community energy in the UK
68	2011	Ribeiro	The inclusion of social aspects in power planning
69	2014	Parag	More than filler, Middle actor and socio-technical change in the energy system from the 'middle-out'
70	2010	Molony	Transitioning to low carbon communities in Australia
71	2010	Middlemiss	Building capacity for low-carbon communities
72	2007	Madlener	Innovation diffusion
73	2010	Manfren	Paradigm shift in urban energy systems through distributed generation
74	2011	Hoppe	Local government inf.
75	2010	Hoffman	From private lives to collective action
76	2011	Heiskanen	Path creation for sustainable consumption, promoting alternative heating systems in Finland
77	2010	Heiskanen	Low-carbon communities as context for individual behavioural change
78	2013	Hargreaves	Grassroots innovations in community energy, the role of intermediaries in niche development
79	2011	Foran	Low carbon transition options for Australia
80	2010	Burch	In pursuit of resilient low carbon communities
81	2010	Aitken	Why we still don't understand the social aspects of wind power, A critique of key assumptions within the literature
82	2015	Schoor	Power to the people, local community initiatives and the transition to sustainable energy
83	2015	Araujo	The emerging field of energy transitions, progress, challenges and opportunities
84	2014	Stern	Individual and household interactions with energy systems, toward integrated understanding
86	2014	Strunz	The German Energy Transition as RegimeShift
87	2014	Oteman	The institutional space for community initiatives for renewable energy, a comparative case study of the Netherlands, Germany and Denmark
88	2014	Suhlsen	Lobbying the Energiewende, assessing the effectiveness of strategies to promote the renewable energy business in Germany
90	2011	Kunze	Social complexity of RE production in countryside
92	2012	Jorgensen	Mapping and navigating transitions
94	2008	Wolfe	The-implications-of-an-increasingly-decentralised-energy-system
95	2008	Power	Does-demolition-or-refurbishment-of-old-and-inefficient-homes-help-to-increase-our-environmental-social-and-economic-viability
96	2008	Roberts	Altering-existing-buildings-in-the-UK
97	1998	Shove	Gaps-barriers-and-conceptual-chasms-theories-of-technology-transfer-and-energy-in-buildings
98	2004	Feder	A regionally based energy end-use strategy, Case studies from Centre country, Pennsylvania

99	2008	Keirstead	What changes, if any, would increased levels of low-carbon decentralised energy have on the built environment?
100	2008	Ward	What are the energy and power consumption patterns of different types of built environment?
101	2008	Crawford	A low carbon future. Spatial planning's role in enhancing technological innovation in the built environment
102	2009	Day	The-use-of-the-planning-system-to-encourage-low-carbon-energy-technologies-in-buildings
103	2008	Ekins	The-impact-of-EU-policies-on-energy-use-in-and-the-evolution-of-the-UK-built-environment
106	2013	Hoffman	Public values and community energy, Lessons from the US and UK
107	2011	Schlembach	Study of debates within camp for climate action
108	2014	Geels	Regime resistance agains low-carbon transitions
109	2011	Meadowcroft	Engaging with the politics of transitions
110	2013	Hargreaves	Up down round and round regimes and practices in innovation
111	2012	Allen	Community based RE Lake District National Park
112	2008	Rogers	Public perceptions of opportunities for community based energy projects
113	2013	Seyfang	A thousand flowers blooming-An examination of community energy in the UK
114	2014	Rodprasert	Green energy community with smart society
115	2015	Slee	Is there a case for community based energy participation in Scottish on-shore wind production
120	2014	Forrest	Learning from success-toward evidence-informed sustainability transitions in communities
121	2011	Trutnevyte	Supporting energy initiatives in small communities by linking visions with energy scenarios
123	2011	North	Climate activism in the UK, a social movement analysis
124	2008	Campoccia	Comparative analysis of different supporting measures for the production of electrical energy by solar PV and wind systems, four representative European cases
126	2012	Hauber	Moving towards energy self-sufficiency based on renewables, comparative case studies on the emergence of regional processes of socio-technical change in Germany
128	2006	Ornetzeder	User-led innovations and participation processes, lessons from sustainable energy technologies
129	2009	Fischer	Re-interpreting regulations, architects as intermediaries for low-carbon buildings
130	1966	Zald	Social movement organisations, growth, decay and change
131	2003	Hensmans	Social Movement Organizations, a metaphor for strategic actors in institutional fields
132	2013	Emelianoff	Local energy transition and Multilevel Climate governance-experiences in Hannover and Vaxjo
133	2010	Henttonen	Exploring social networks on the team level, a review of the empirical literature
134	2013	Blarke	Supergrid or smartgrid, competing strategies for large-scale integration of intermittent renewables?
136	2011	Foxon	A coevolutionary framework for analysing a transition to a sustainable low carbon economy
137	1996	Megbolugbe	Understanding neighbourhood dynamics, a review of the contributions of William G. Grigsby
139	2012	Hawkins	Sustainable Development Governance, Citizen participation and support networks in local sustainability initiatives
140	2009	Hall	Empowerment of individuals and realization of community agency, applying Action Research to climate change responses in Australia
141	1990	Wilson	Organizational correlates of citizens participation association effectiveness
142	1998	Nijkamp	A meta-analytical evaluation of sustainable city initiatives
143	1938	Jones	Citizen groups, tool of democracy
144	2011	Jun	How are we doing, a multiple constituency approach to civic association effectiveness
148	2012	Shamsuzzoh a	Implementation of renewable energy in Scottish rural area, a social study
149	2009	Cass	Emotion and rationality, the characterisation and evaluation of opposition to renewable energy projects
150	2009	Bodorkos	Linking academic and local knowledse, community based research and service learning for sustainable rural development in Hungary
151	2011	Ulsrud	The solar transitions research on solar mini-grids in India, learning from local cases of innovative socio-technical systems
152	1999	Hanley	Appraising renewable energy developments in remote communities, the case of the North Assynt Estate Scotland

154	2011	Kemp	The dual challenge of sustainability transitions
155	2011	Leenheer	Own power., Motives of having electricity without the energy company
156	2010	Whitmarsh	Public engagement with carbon and climate change, to what extent is the public carbon capable
157	2009	Thorp	Affordable and sustainable energy in the Borough of Woking in the UK
158	2010	Seyfang	Community action for sustainable housing, building a low-carbon future
159	2010	Shove	Governing transitions in the sustainability of every life
161	2005	Holden	Three challenges for the compact city as a sustainable urban form, household consumption of energy and transport in 8 residential areas in the Greater Oslo Region
162	2009	Hughes	An applied local sustainable energy model, the case of Austin, Texas
163	2001	Bassam	Renewable energy for rural communities
164	2008	Barry	Cool rationalities and hot air, a rhetorical approach to understanding debates on renewable energy
165	1998	Barton	Eco-neighbourhoods, A review of projects
166	2007	Alexander	Mainstreaming Sustainable Development, A case study, Ashton Hayes
168	2011	Musall	Local Acceptance of renewable energy, a case study from southeast Germany
169	2010	McLoughlin	Rethinking political process in technological change
170	2007	Geels	Feelings of discontent and the promise of middle range theory for STS
171	2012	Buchan	The Energiewende, Germany's gamble-working paper
172	2011	Bergman	What role for microgeneration
173	2007	Betsill	Looking back and thinking ahead: a decade of cities and climate change research
174	2012	Bridge	Geographies of energy transition
176	2013	Bulkely	Revisiting the urban politics of climate change
177	2007	Burton	Is small beautiful, a multicriteria assessment of small-scale energy
178	2009	Byrne	Relocating energy in the social commons
179	2013	Catney	Big Society, little justice, community renewable energy and the politics of localism
180	2013	Catney	Community knowledge networks, an action-oriented approach to energy research
181	2007	Chen	Renewislands-Renewable energy solutions for islands
183	2002	Curtis	Eco-localism and sustainability
184	2007	DelRio	Assessing-the-impact-of-renewable
185	2008	DelRio	Empirical analysis of impact of renewable energy deployment on local sustainability

Appendix B. Keywords in the community energy literature

100% renewable energy systems	contingent valuation	entrepreneurs
activism	cooperatives	environmental awareness
actor-worlds	criteria	environmental citizenship
actors' navigation	customer incompetence.	environmental planning
adaptation	data envelopment analysis	environmental psychology
advisory community organizations	decentralisation	equity participation
agency	decentralized energy production	Europe
agency and capacity	demand management	everyday practice
analytical-evaluative framework	destabilization	feed-in tariff
architects	development	feed-in-tariffs
arenas of development	discourse	feedback
australia	distributed generation	field theory
aviation	drinking water	financing channel
backcasting	dutch electricity system	financing instrument
barriers	eco-cities	follow-up and spin-off
behaviour change	economic geography	geographies of transitions
behaviour change programmes	effectiveness	Germany
beWhere	efficiency gap	globalization
biomass district heating	electricity	governance
bounded socio-technical experiments	electricity generation	governance for sustainability
building retrofitting	electricity supply	grassroots
building stock	embedded generation	grassroots action
capacity	embodied energy	grassroots innovations
carbon	emission reduction	green electricity
carbon governance	emotions	green energy community
carbon lock-in	empirical literature	green tags
carbon reduction	empowerment	greening innovation systems
challenges	end-use analysis	grids
cities	Energiewende	groups
citizen groups	energy	Hannover
citizen participation	energy and growth	heat island
civic engagement	energy autarky	heat maps
civil society	energy autonomy	heat pumps
climate change	energy behaviour	history of backcasting
climate change experiments	energy conservation	home, work and leisure
climate change policy	energy efficiency	households
climate mitigation	energy initiatives	housing
coal	energy management	housing refurbishment
coevolution	energy neutrality	hybrid renewable energy systems
combined heat and power	energy performance	incentives
common pool resources	energy performance in buildings	incumbent regimes
communities	energy policy	incumbents
community	energy potential mapping	individuals
community currencies	energy region	information management
community energy	energy services directive	informed cities
community energy management	energy system	innovation
community energy plan	energy system based on renewable	innovation diffusion
community initiatives	energy system change	innovation niches
community ownership	energy system transition	innovation system failures
community-based research	energy transition	institutional arrangements
competence	energy vulnerability	institutional change
complementary currencies	energy-industry symbiosis	institutional fields
constructive technology assessment	engagement	institutional space
consumption	England	insulation

intermediaries	policy and governance	social organization
isolated micro-communities	policy options	social practice theory
Joseph Schumpeter	political- cultural perspective	social practices
Lake District	politics	social Research
learning	population	social study
legitimation	power	socio-economic aspects
levelized cost of energy	practice	socio-technical analysis
lobbying	practices	socio-technical change
local actors	pro-environmental behaviour	socio-technical configurations
local climate governance	processual analysis	socio-technical regimes
local climate policy	production	socio-technical transitions
local energy company	promotion instruments	sociotechnical system
local energy planning	prosumers	solar mini-grids
local governments	protective space	spatial planning
local organic food	public	stakeholder participation
lock-in	public acceptance	state
long-term industrial change	public understanding	storage
long-term socio-technical analysis	public works	strategic energy planning
low carbon	PV systems	Strategic Niche Management
low carbon city	R&D	strategies
low-carbon communities	rebound	strategy
low-carbon dwellings	recruitment	structural economic change
low-carbon economy	regime	success conditions
low-carbon lifestyles	regime shift	Sunderban Islands
managerial representations of the	regional development	SuperGrid
Mancur Olson	regional energy modeling	support policies
microgeneration	regional geography	sustainability
microgrid	regulation	sustainability interventions
middle actors	remote villages	sustainability transitions
middle-out	renewable	sustainable
multi-level perspective	renewable energy	sustainable communities/cities
multi-modal research design	renewable energy communities	sustainable consumption
multicriteria decision-making	renewable energy policy	sustainable development
multidisciplinary optimization	renewable energy sources	sustainable energy
multilevel climate governance	renewable energy technologies	sustainable energy communities
multiobjective optimization	repertory grid	sustainable energy technology
multiple constituency approach,	research	sustainable homes
municipal energy plans	research agendas	sustainable housing
narratives	residential energy efficiency	sustainable innovation
natural trajectories	residential heating	Sustainable rural development
net metering	resilience	sustainable urban development
network-bound systems	resistance	tacit knowledge
niche	retrofits	targets
normative scenarios	review	teams
North America	rural	techno-economic paradigm
off-grid islands	rural Development	Technological innovation systems
off-grid solar power supply	SAP	technology transfer
organizational effectiveness	science shop	the Netherlands
own power	scotland	theory and practice
ownership	service learning	trans-disciplinary
participation	small groups	transition pathways
Participatory Action Research (PAR)	smart grid	transition pathways/mechanisms
particle emission	social acceptance	transition theory
path creation	social aspects	transitions
path dependency	social change	trust
phase model	social housing	UK
place	social innovation	UK energy use
place attachments	social learning	UK policy
planning	social movement organizations	urban design
policy	social movements	urban energy transition
policy analysis	social networks	urban planning

urban regeneration	waste water management	
urban renewal	wind	
urban sustainability policy	wind energy	
urbanization	wind systems	
user-led innovations	wood-burning stoves	
users	zero carbon	
value co-creation	wind	
Växjö	wind energy	
vested interests	wind systems	
visions	wood-burning stoves	
voluntary civic associations		